

# **BARK BEETLE MANAGEMENT ACTIONS ON THE 1998 SILVER CREEK FIRE**

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The summer of 1998 was one of the warmest and driest seasons on record in the southern Interior of British Columbia, as with most regions in Canada. Average daily temperatures in the Salmon Arm area were approximately 4.2°C above normal and measured near 30°C for July and August. Lack of measurable rain and lower than average humidity also contributed to dry forest conditions (Joy and MacLauchlan 1999).

The British Columbia Ministry of Forests Protection Branch uses the "Drought Code" (DC) to determine moisture content of large woody debris in an area. When the DC reaches 400, fire hazard is considered extreme. In late July 1998, the DC for the Salmon Arm area was calculated at >700 (Kamloops Fire Centre 1998).

On July 29, lightning struck the upper reaches of Silver Creek, within the Interior Cedar Hemlock (ICH) and Engelmann Spruce-Subalpine fir (ESSF) transition zones. Early afternoon winds of up to 200 kph on August 5 caused a massive expansion of the fire north and east along Fly Hills. The fire quickly crossed the valley onto the east and north slopes of Mt. Ida (Fig. 1).

The fire affected 6,500 hectares, approximately 85% of which is Crown land. Six forest licences are held on this area. The fire resulted in the largest evacuation of residents in B.C. history and in significant losses on private land. The viewscape in the valley has been dramatically affected and there has been considerable concern for community watersheds and the potential impacts of erosion. In addition, Mt. Ida has cultural and spiritual significance to the people of the Adams Lake, Neskonlith and Spallumcheen Bands.

Since the fire in 1998, the Ministry of Forests and forest licencees have implemented many post-fire management treatments on both Crown and private property, designed to protect the hydrologic, soil, environmental and land resources (Salmon Arm Forest District 1999). Approximately 425,000 m<sup>3</sup> of burnt wood has been salvage harvested. In 1999 and 2000, over 700 ha of non-harvested area were aerial tree seeded. Much of the harvested area has been replanted (1,324 ha; >2.6 million seedlings), with more planting planned for spring 2001 on over 500 hectares (Salmon Arm Forest District 2000). Other treatments and activities include assessments to evaluate environmental risks (e.g. hydrological, biodiversity and wildlife impacts), access management, erosion control, site

preparation (e.g. stumping and snag falling), establishment and monitoring of forest health permanent sample plots, and visual modelling.

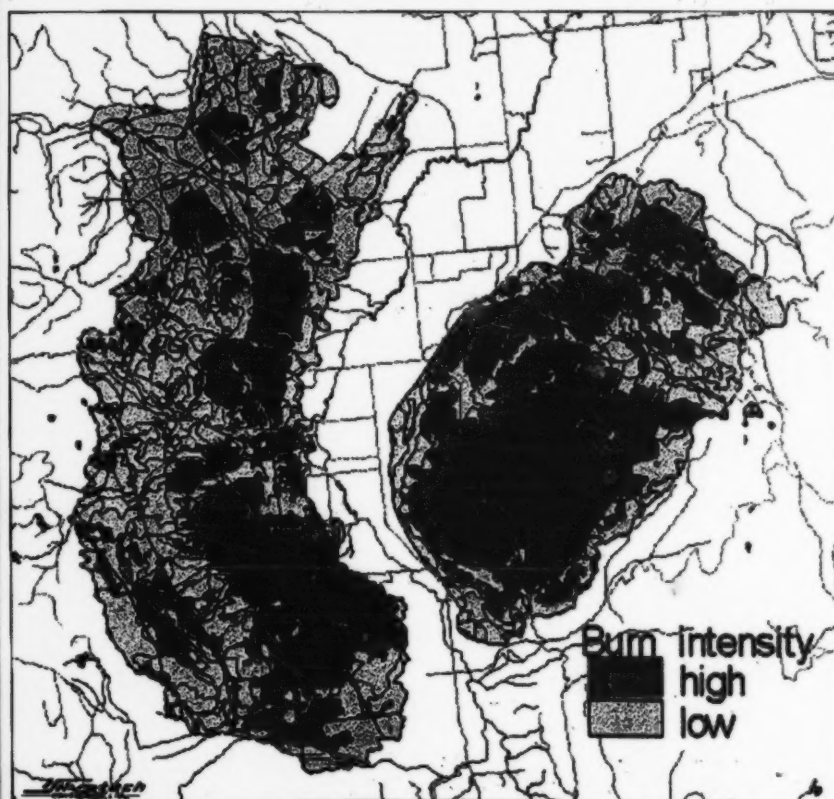


Figure 1. Map showing areas of different burn intensity of the Silver Creek Fire.

## Douglas-fir beetle and western pine beetle biology and the role of chemical communication

The Douglas-fir beetle (DFB, *Dendroctonus pseudotsugae* Hopkins), native to south central B.C., is considered to be the most destructive insect of mature Douglas-fir (*Pseudotsuga menziesii*) throughout the tree's range in western North America (Furniss and Carolin 1977). At low population levels, DFB normally maintain themselves in windthrown or otherwise stressed fir trees, which are the beetle's preferred host. In these situations this beetle is considered a secondary or opportunistic insect. Population levels may build in areas that suffer stand disturbance events such as fire, drought, blowdown, or in areas with significant root disease. Once epidemic levels are reached, beetles attack apparently healthy trees (Humphreys 1995).

Adult female beetles emerge from their host in early spring when ambient temperatures reach approximately 18°C, traditionally May or early June in the Salmon Arm area. Adults developing from overwintering larvae, and re-emerging adults of the early or "spring flight", may make a second or "summer flight" (Humphreys 1995).

Pioneer beetles (females in this species) search and locate suitable host trees by responding to visual and kairomonal cues of host and non-host trees. Kairomones are chemicals released by one species that elicit a response in, and provide benefit to, another species. Once at a host tree, beetles emit a semiochemical message that attracts others of their species (conspecifics) to join them. This message is made up of several chemicals, or pheromones, which act synergistically. The coordination of a mass attack, made possible by aggregation pheromones, allows beetles to overcome a tree's defense systems. Once the population density begins to reach a maximum in a host, beetles emit antiaggregation pheromones that signal to conspecific beetles that there is "no vacancy" remaining in the tree.

Aggregation pheromones produced by the DFB include frontalin, seudenol and MCOL (1-methylcyclohex-2-en-1-ol). Ethanol is a kairomonal attractant produced by the host tree. The chemical MCH or 3-methyl-2-cyclohexen-1-one is an antiaggregation pheromone produced by the Douglas-fir beetle (Ross and Daterman 1997).

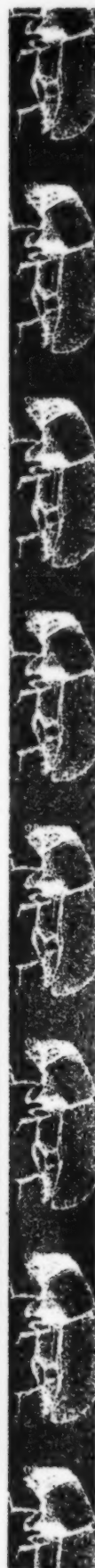
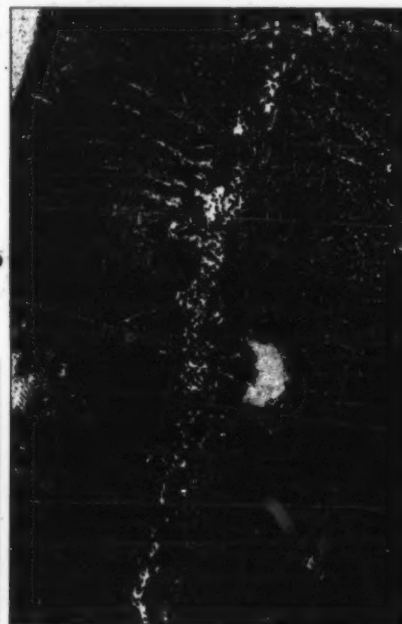
Once at a host tree, each beetle pair

commences the excavation of an egg gallery under the bark, parallel to the grain. Mating occurs on the bark or in the gallery. As the gallery is built, the sapwood is inoculated with a blue stain fungus that is carried by the beetles. The female lays her eggs in groups, in niches that alternate along the sides of the egg gallery. The eggs hatch into larvae which feed on the phloem tissue at right angles to the egg gallery (Fig. 2). The young grow under the shelter of the bark (Fig. 2), developing through four larval instars, a pupal stage, then transforming into adults. The brood may overwinter as either larvae or young adults and emerge the following year to attack more trees. Douglas-fir beetles are known to be strong fliers and may travel several kilometres to suitable host trees (Humphreys 1995; B.C. MoF and CFS 1999).

Tree death results from the combined effects of larval feeding and the fungal colonization of the sapwood which block the flow of water and nutrients. Typically the crowns of successfully attacked trees turn red the spring following attack however, sometimes foliage symptoms are recognizable the same year (Humphreys 1995).

The western pine beetle (WPB, *Dendroctonus brevicornis* LeConte) mainly attacks ponderosa or yellow pine (*Pinus ponderosae*) in B.C. This is a relatively minor pest in the province, as its host species is usually a minor stand component restricted to dry low elevation valley bottoms. Large areas of mature ponderosa pine (and Coulter pine) have been decimated in the western U.S.A. and there are

Figure 2. Douglas-fir beetle galleries, showing larval galleries at right angles to the central parent gallery (right) and close-up of DFB larvae and adult (left).



historical records of large outbreaks in B.C., south of Princeton (L. MacLauchlan, pers. comm. 2001). The biology of this beetle is similar to the DFB as they belong to the same genus. In the northern part of their range and at higher elevations, the beetles normally produce two generations per year, which attack trees in early June and in late August. The gallery of this beetle is quite distinct and is described as "serpentine-like" (Fig. 3).

Semiochemicals (pheromones and kairomones) also play an important role in the life history of the western pine beetle (Demars and Roettgering 1982). Pheromones produced by the WPB include frontalinal and *exo-brevicornin*. Myrcene is a kairomone produced by the host tree.

### Forest Health Monitoring and Management

Within the fire area, damage to forest land ranged from unburned areas to areas with complete tree and understory mortality (Fig. 1). Sixty percent of the burn area was identified as low intensity (i.e. only scattered tree mortality, with charred boles and mainly green crowns) (Fig. 1). The predominant tree species over the fire area is interior Douglas-fir located within the Interior Douglas-fir (IDF) biogeoclimatic zone.

Over the spring and summer of 1999, field staff identified Douglas-fir beetle in heavily scorched fir in numerous areas within the fire area. Western pine beetle populations were also detected in ponderosa pine within the burn. These beetles are endemic throughout much of the Salmon Arm District. Initially, the insects of concern were secondary opportunistic pests such as woodborers, ambrosia beetles and bark beetles, such as pine and fir engravers.

In July and August 1999, nineteen fixed area permanent sample plots were established and assessed within low intensity burn areas. The objectives of the plots are:

- 1) to determine the short and long-term incidence and impact of pests in areas mapped as low intensity burn; and
- 2) to determine if different ecosystems are more susceptible to pest impacts following fire and what level of fire scarring creates a more susceptible host.

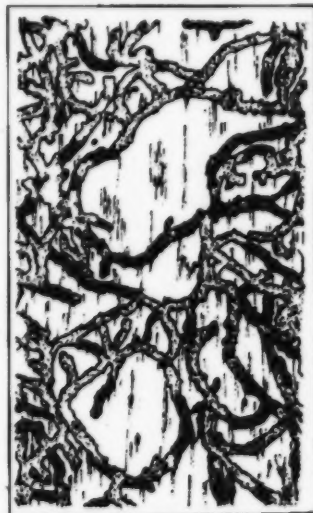
Douglas-fir beetle was the most common insect pest on Douglas-fir in the permanent sample plots and was found on 5% of all fir (>12.5 cm dbh) sampled. Eighty percent of the attacks occurred on live trees that had suffered severe basal scorching and the remainder was found on severely scorched dead fir (Hodge 1999).

An increase in Douglas-fir beetle over the fire area was not unexpected, as the beetle's preferred host materials are stressed and/or dying trees, and there already was a resident beetle population in the area. In addition, the weather during the spring and summer of 1999 was unusually cool and wet, allowing the phloem of larger diameter, thick barked, fire-killed fir trees to remain suitable for brood development much longer than anticipated. Many trees with no live crown remaining, contained successfully developed brood when examined in the summer and fall of 1999.

It should be noted that drought-related mortality was observed throughout the Kamloops Region on over 10,000 hectares of young and mature stands in 1999 (Joy and MacLauchlan 1999). From the Regional aerial overview, 4,030 hectares of drought mortality were mapped in the Salmon Arm District, the majority occurring on dry sites at mid to low elevations (Kamloops Forest Region 1999). A combination of direct physiological damage, secondary pests (including Douglas-fir beetle, twig beetles, *Hylurgops* and *Hylastes* sp., pine and fir engravers, lodgepole pine beetle, turpentine beetle and Yosemite bark weevil) and root disease were responsible for much of this mortality. It has been documented that past drought events have triggered outbreaks of Douglas-fir beetle in the province (Joy and MacLauchlan 1999).

There was concern that the DFB population building in fire damaged trees, could in subsequent years, move into adjacent, healthy stands and cause further stand mortality in the area. The stands south of the fire, on the east and west slopes of the Silver Creek Valley, and on the eastern edge of the fire, on Mt. Ida, have a high mature Douglas-fir component. The large openings already created by the fire and associated salvage harvesting and the proximity to town and private property made management of beetles a priority. Although ponderosa pine comprises a small component of the local ecosystem, it is important to the biodiversity of the area. Therefore, potential mortality by WPB was also a concern.

Figure 3. Serpentine-shaped galleries of the western pine beetle.



In September, a full 100-meter grid probe was initiated in known infestation areas within the burn. After 2 weeks, the consultants reported that their task was too onerous as initially planned. Criteria were then developed to group areas into Nil, Low, Moderate or High DFB infestation levels and/or high infestation risk. Representative field sample plots were established and trees >35 cm diameter at breast height (dbh) were examined for DFB. Attack levels for each stratum were based on the number of trees affected and on brood development. Western pine beetle infestations were also noted. Risk was based on the number of green susceptible trees remaining in the stratum and the proximity of the nearest infestation (SilvaTech, 1999).

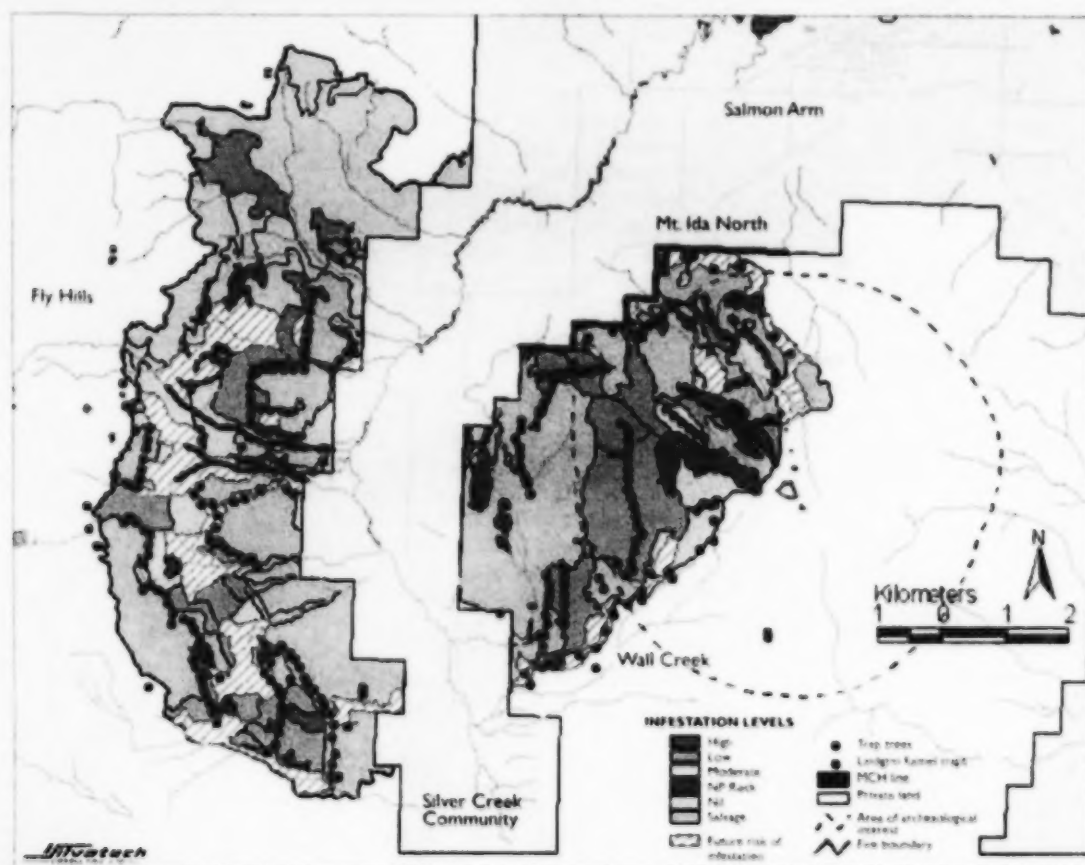
The North face of Mt. Ida, Wall Creek and Fly Hills were divided into 20, 16 and 45 strata respectively (Fig. 4). Approximately 3,000 hectares of area were infested with DFB to some degree and only 5 of

the 81 strata had no fir component. Seven of 27 strata with ponderosa (yellow) pine in their timber type contained WPB infested trees.

Trees on private property in the area were examined for DFB and WPB attack in early 2000. Ten landowners had infested trees on their property, however the majority of infestations involved less than 10 attacked trees. A public meeting was held in February to inform the community of DFB and WPB presence and management on Crown land and describe control options available for private land owners.

There are a number of tactics commonly used to manage DFB populations in the working forest of B.C. and to reduce the amount of mortality caused by outbreaks. Preventative tactics including the removal of logging slash and the prevention and removal of

Figure 4. Map showing infestation levels of Douglas-fir beetle, trap sites, and MCH treatment zone



blowdown are important for minimizing breeding material. Other important tactics include the use of trap trees and sanitation harvest. Trap trees are accessible live, large diameter fir trees that are felled in early spring and left on the ground. These trees concentrate and contain DFB because of the beetles preference for down wood as compared to healthy, standing hosts. Trap trees are removed and processed before the next beetle flight, thus removing beetles from the area. Sanitation harvesting involves the reduction of beetle population levels through logging. Prioritization for harvesting stands is based on levels of green (new) attack and the potential for

spread to adjacent areas (B.C. Ministry of Forests 1995).

Early into the field assessment, it became apparent that the opportunity available for conventional harvesting and trap trees would not be sufficient to control the DFB. Much of the remaining forested area was identified as inaccessible and/or inoperable and there was a strong effort to retain nonharvested areas to meet other management objectives. Therefore, the potential use of aggregation pheromones for mass-trapping and anti-aggregation pheromones was explored.

Table 1. Calendar of activities for Silver Creek Fire Bark Beetle Management Plan development and implementation, spring 1999 to winter 2001.

| Year | Date              | Activity                                                                                                                                                                                                                                          |
|------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1999 | Spring - Summer   | DFB and WPB attack noticed by field crews in fire area                                                                                                                                                                                            |
|      | July - August     | Permanent Sample Plot data confirmed beetle presence                                                                                                                                                                                              |
|      | Sept. - Nov.      | Field survey conducted to stratify infestation and assess risk                                                                                                                                                                                    |
|      | November          | Meetings and discussions with USFS and other bark beetle management specialists                                                                                                                                                                   |
|      | December 22       | Survey report and infestation maps received                                                                                                                                                                                                       |
| 2000 | January           | <ul style="list-style-type: none"> <li>Action Plan completed</li> <li>Private Property bark beetle surveys completed</li> <li>Initial meeting with First Nations regarding bark beetle concern</li> <li>Public Meeting in Silver Creek</li> </ul> |
|      | February          | <ul style="list-style-type: none"> <li>Locations of trap sites, trap tree patches and MCH defined</li> <li>Contractual agreement with the SRWS in place for summer field crew</li> </ul>                                                          |
|      | March 1           | Trap site layout and rebar delivery (by snowmobile) commenced                                                                                                                                                                                     |
|      | March 15          | Trap tree patch felling commenced                                                                                                                                                                                                                 |
|      | March 21          | Preparation and organisation of funnel traps and lures                                                                                                                                                                                            |
|      | March 27          | 12-person crew start trap set-up and MCH installation                                                                                                                                                                                             |
|      | April 10          | First DFB found in traps in Wall Creek                                                                                                                                                                                                            |
|      | April 11          | <ul style="list-style-type: none"> <li>All trap sites set-up and MCH installed, except for high elevation areas</li> <li>12-person crew reduced to 4 members</li> </ul>                                                                           |
|      | April 12 - May 9  | Trap repairs, lure securing and monitoring                                                                                                                                                                                                        |
|      | May - November    | Trap collections dried and weighed by Regional lab crew                                                                                                                                                                                           |
|      | May 10            | Round 1 trap collections commenced                                                                                                                                                                                                                |
|      | May 24-31         | Remaining high elevation trap sites set-up                                                                                                                                                                                                        |
|      | June 20 - July 15 | Trap tree patches examined and additional trees added to patches                                                                                                                                                                                  |
|      | June 27 & July 12 | New trap lines established (4 sites total)                                                                                                                                                                                                        |
|      | June 30 - July 10 | Lure replacement at all but high elevation trap sites                                                                                                                                                                                             |
|      | Mid August        | MCH line walkthrough surveys                                                                                                                                                                                                                      |
|      | Aug. 28 - Sept. 1 | Final trap collection period (Round 12)                                                                                                                                                                                                           |
|      | September 5-29    | Trap dismantling, retrieval and trap cleanup                                                                                                                                                                                                      |
|      | October           | Bark beetle surveys commenced on east side of valley (Mt. Ida)                                                                                                                                                                                    |
|      | October 5-8       | Presentation of project and results at DFB Workshop, Nelson For. Reg.                                                                                                                                                                             |
|      | Mid October       | Trap tree patches examined for DFB occupancy                                                                                                                                                                                                      |
| 2001 | Dec. 2000 - Feb.  | Trap tree patches removed and green attack harvested on Mt. Ida                                                                                                                                                                                   |
|      | January 17        | Information seminar presented at SRWS meeting                                                                                                                                                                                                     |
|      | January-March     | <ul style="list-style-type: none"> <li>Fall and burn most inaccessible green attack</li> <li>2000 treatment evaluation and development of 2001 treatment plan</li> </ul>                                                                          |

## Control Program

In November 1999, BCFS representatives attended an information-sharing meeting on DFB management alternatives hosted by the U.S. Forest Service in Coeur d'Alene, Idaho. The operational use of mass trapping and antiaggregation pheromones in the northwestern states was discussed.

A management plan for bark beetles on the Silver Creek fire was developed in consultation with specialists and researchers from both Canada and the U.S.A. In December 1999, the Salmon Arm District Forest Health Officer and District Management team signed an Action Plan. The identified objective of this plan was to "contain and reduce insect (DFB and WPB) populations to endemic levels to minimize any further timber losses within and nearby the fire area." District staff developed and implemented the plan with the involvement of forest licencees and local First Nations.

The plan incorporated three main management tactics:

- 1) mass trapping with aggregation pheromones (DFB and WPB);
- 2) the use of antiaggregation pheromones (DFB), and;
- 3) trap trees (DFB).

This was one of the first operational trials of MCH in the province using the product and methodology described. It was also one of the largest operational bark beetle mass trapping programs in North America. This plan provided opportunity for the assessment of both of these management tactics. Table 1 is a chronological summary of events leading up to the plan development, through to plan

implementation and follow-up, winter 2000/2001.

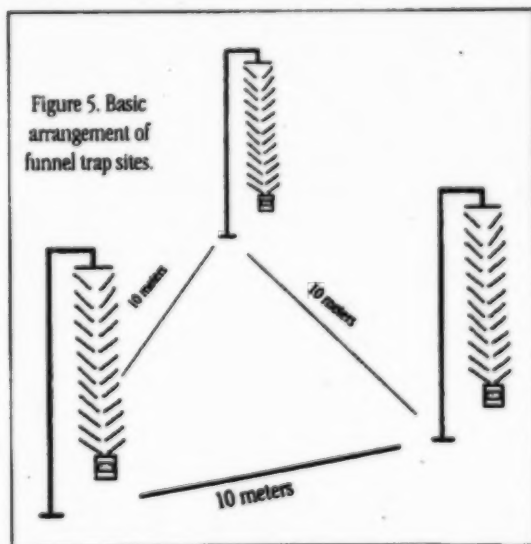
The number of beetles caught in traps was initially used to indicate efficacy of the tactics. Overall success of these treatments would be assessed by ground surveys in the fall on the Mt. Ida side. Small-scale follow-up treatments including small patch harvesting (particularly in trap overflow areas) in conjunction with trap tree removal and single tree disposal (fall and burn or peel) were expected. Plans for 2001 would depend on the success of the 2000 plan and the amount of green attack remaining after follow-up treatments.

## Mass Trapping

Bark beetle mass trapping entails the use of Lindgren funnel traps (Lindgren 1983) baited with species-specific beetle attractants (usually a synthetic blend of beetle aggregation pheromones and/or host kairomones). Commercial baits for the DFB and WPB are available in B.C. from Phero Tech Inc. (Delta, B.C.). Traps collect beetles as they fly through an area and are attracted to the lure. Beetles fall into a collection cup and cannot escape. Traps have been used in the past to successfully "trap-out" small isolated beetle populations. Mass-trapping large, widespread populations has not been widely advocated because other tactics such as sanitation harvesting and the use of trap trees are thought to be more cost-effective and appropriate on a large scale, and are generally believed to be the most efficient tactics in dealing with these situations.

It was mutually decided that the coordination and implementation of mass trapping would be most successful under one manager and the Salmon Arm Forest District Forest Health Officer filled this role. A field crew and supervisor were hired to assist.

Utilizing the stratum information, trap lines were established to capture beetles flying from infested areas and to minimize potential of overflow attack on green trees around the traps. A total of 232 DFB funnel trap sites were established over the fire area on 32 trap lines (Figs. 4). Mt. Ida North, Wall Creek and Fly Hills had 62, 48 and 122 sites respectively. Trap sites on a trap line were spaced approximately 150 m apart. Each site consisted of three, baited Lindgren 12-unit multiple funnel traps (totalling 696 traps) spaced in a triangular configuration approximately 10m apart. Traps were either hung from (dead) trees or rebar placed in the ground and supported with rope (Fig. 5). A piece of 12 x 12 mm wire mesh screen was placed in the last funnel of each trap to facilitate the escape of larger nontarget insects, specifically scolytid predators (Ross and Daterman 1998).



The release rate for the frontalinal component of the DFB lure was adjusted to a higher rate based on the improved response observed by Ross and Daterman (1998). The estimated release rate for each component of the DFB lure was as follows (Phero Tech Inc. 2000):

- Frontalin eppendorf tube – 2.6 mg/day x 2 vials = 5.2 mg/day
- Ethanol sleeve – 30 to 50 mg/day
- MCOL bubblecap – 2.0 mg/day

Eighteen sites (54 traps total) were established to trap WPB on the lower elevations of the fire area and the same trap configuration was used (Fig. 3). The estimated release rate for each component of the WPB lure was as follows (Phero Tech Inc. 2000):

- Exo-brevicomin bubblecap – 1.7 mg/day
- Myrcene bubblecap – 6.5 mg/day x 2 – 13.0 mg/day
- Frontalin eppendorf tube – 2.6 mg/day

In late March, crewmembers began trap setup and on April 10, the first DFB were found in traps in Wall Creek. In early July, all lures were replaced except for higher elevation sites that had only been established a month previous. In early September, trap dismantling and retrieval was initiated. Remnant trap catches were collected but were not counted – the majority of the DFB flight had ceased by this date. Some WPB traps continued to be active due to warm weather conditions and these traps were dismantled last.

Trap collections were tallied in order to assist in the assessment of the mass trapping tactic. This added considerable expense to the trapping project as a whole. Field crew began individual trap collections on May 10. Twelve collection rounds were completed by the end of August with 6,148 individual collections being made in approximately 125 days. Collections were stored frozen until counted. Most sorting and counting occurred in the Entomology lab at Kamloops Forest Region. This process was very labour intensive. Beetles were grouped by site and oven-dried. Non-target insects and debris were removed and dry weights were taken. A regression line for both DFB and WPB was determined for correlating beetle weights to beetle numbers. Dry weights were used to estimate beetle numbers.

An estimated 1,545,536 DFB were collected in the 696 fir beetle traps throughout the season (Table 2). The peak flight period occurred in early June in the three locations (Mt. Ida N., Wall Creek and Fly Hills) and an average of 180 beetles was collected/trap/day over the entire fire area (Fig. 6). There is an apparent correlation between a decrease in trap catch numbers and lower than average daily temperature (associated with heavy rain) in mid-June. Beetle catch/trap/day dropped significantly after the beginning of July. A second flight was not detected by trap catches.

Table 2. Summary of Douglas-fir and western pine beetle funnel trap collections by collection round over the Silver Creek fire area in the 2000 season. Beetle numbers are estimated from dry weights.

| Collection Round | Dates           | No. traps | No. DFB   | No. DFB/trap/day | No. traps collected | No. WPB collected | No. WPB/trap/day |
|------------------|-----------------|-----------|-----------|------------------|---------------------|-------------------|------------------|
| 1                | May 10-May 18*  | 491       | 212531    | 14.4             | 8143                | 50                | 5.4              |
| 2                | May 19-June 2   | 479       | 340501    | 47.4             | 7167                | 46                | 10.4             |
| 3                | June 5-June 9   | 453       | 408866    | 180.5            | 17120               | 49                | 69.9             |
| 4                | June 12-June 16 | 500       | 45314     | 18.1             | 3150                | 46                | 13.7             |
| 5                | June 19-June 23 | 507       | 140946    | 55.6             | 9411                | 54                | 34.9             |
| 6                | June 26-July 5  | 601       | 255365    | 42.5             | 10465               | 51                | 20.5             |
| 7                | July 05-July 12 | 610       | 43819     | 9.0              | 6840                | 40                | 21.4             |
| 8                | July 13-July 19 | 633       | 46951     | 10.6             | 6635                | 50                | 19.0             |
| 9                | July 20-Aug 1   | 609       | 24632     | 3.1              | 9625                | 51                | 14.5             |
| 10               | Aug 2-Aug 15    | 632       | 20214     | 2.3              | 17895               | 50                | 25.6             |
| 11               | Aug 16-Aug 23   | 33        | 423       | 1.6              | 14995               | 50                | 37.5             |
| 12               | Aug 28-Sept 1   | 600       | 5974      | 2.0              | 8675                | 51                | 34.0             |
| Entire Season    |                 | 6148      | 1,545,536 | 2.0              | 120,121             | 588               | 1.6              |

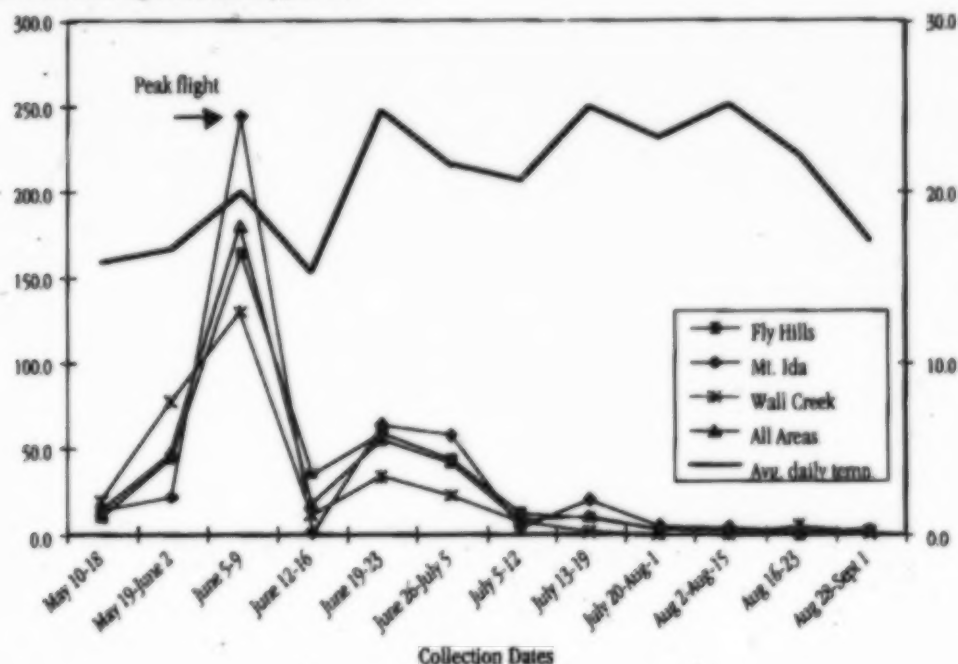
\* The actual time over which traps in the first round were collecting beetles was estimated to be 30 days, as the flight began on or about April 10, 2000.

Specific trap lines performed much better than others did and average catch/trap/day in field by trap line ranged from approximately 1 to over 50. An examination of individual trap line performance was done and will be used as a planning tool for the 2001 follow up program (Table 3). Many factors may influence trap catches on a trap line including the proximity and number of adjacent infested trees, adjacent stand composition (i.e. number fir stems per hectare), trap exposure, aspect, elevation, prevailing wind direction, proximity to trap tree patches and proximity to susceptible or newly attacked host material. In general, trap lines with a proportion of adjacent strata classified as highly infested had higher catch numbers. High trap catch numbers on trap line Q on Mt. Ida N. may appear anomalous as adjacent strata show nil infestation. However, this may be explained because these traps were installed immediately adjacent to newly attacked trees to

Table 3. Trap line collection rate and 1999 infestation status and future infestation risk of adjacent stratum (i.e. stratum within 400m of trap line). Trap lines are sorted by location from highest DFB collection rate to lowest DFB collection rate over the field season. Collection rate is defined as the number of DFB collected per number of traps on line per number of days traps were in the field.

| Location   | Trap Lines | #DFB/traps on line/<br>#days in field<br>By location | Percentage of adjacent stratum (by area)<br>classified by the 1999 infestation categories |      |      |      | Proportion of adjacent<br>stratum (by area) showing<br>high future infestation risk |
|------------|------------|------------------------------------------------------|-------------------------------------------------------------------------------------------|------|------|------|-------------------------------------------------------------------------------------|
|            |            |                                                      | Nil                                                                                       | Low  | Mod  | High |                                                                                     |
| Wall Creek | A          | 38.9                                                 | 42.9                                                                                      | 43.9 | 10.6 | 2.6  | 52.2                                                                                |
|            | C          | 21.8                                                 | 22.2                                                                                      | 73.4 | 4.4  | 0    | 4.4                                                                                 |
|            | D          | 21.7                                                 | 0                                                                                         | 92.6 | 6.6  | 0.8  | 6.6                                                                                 |
|            | E          | 17.4                                                 | 0                                                                                         | 41.1 | 58.9 | 0    | 40.3                                                                                |
|            | CI         | 16.9                                                 | 0                                                                                         | 29.5 | 70.5 | 0    | 70.5                                                                                |
|            | B          | 16.0                                                 | 0                                                                                         | 84.2 | 15.8 | 0    | 84.2                                                                                |
|            | F          | 9.6                                                  | 0                                                                                         | 97.8 | 2.2  | 0    | 0                                                                                   |
|            | P          | 4.2                                                  | 100                                                                                       | 0    | 0    | 0    | 100                                                                                 |
| Mt. Ida N. | Q          | 81.1                                                 | 100                                                                                       | 0    | 0    | 0    | 100                                                                                 |
|            | K          | 44.4                                                 | 0                                                                                         | 84.4 | 0    | 15.6 | 20.1                                                                                |
|            | M          | 36.7                                                 | 57.9                                                                                      | 15.5 | 0    | 26.6 | 57.9                                                                                |
|            | I          | 25.6                                                 | 0                                                                                         | 40   | 60   | 0    | 40                                                                                  |
|            | H          | 19.4                                                 | 41.8                                                                                      | 21.1 | 57.1 | 0    | 41.8                                                                                |
|            | L          | 15.1                                                 | 0                                                                                         | 74   | 26   | 0    | 0                                                                                   |
|            | G          | 5.3                                                  | 8.6                                                                                       | 83.3 | 8.1  | 0    | 8.1                                                                                 |
|            | N          | 3.2                                                  | 0                                                                                         | 88.1 | 11.9 | 0    | 0                                                                                   |
|            | O          | 2.9                                                  | 0                                                                                         | 89   | 11   | 0    | 0                                                                                   |
| Fly Hills  | J          | 2.7                                                  | 0                                                                                         | 64.8 | 23.2 | 12   | 0                                                                                   |
|            | CC         | 54.1                                                 | 32.6                                                                                      | 0    | 0    | 67.4 | 100                                                                                 |
|            | DD         | 43.2                                                 | 32.6                                                                                      | 0    | 0    | 67.4 | 100                                                                                 |
|            | BB         | 32.6                                                 | 22.4                                                                                      | 35.6 | 1.5  | 40.5 | 58.9                                                                                |
|            | EE         | 25.1                                                 | 93.5                                                                                      | 0    | 0    | 6.5  | 17.5                                                                                |
|            | NN         | 15.6                                                 | 58.3                                                                                      | 32.7 | 4.8  | 4.2  | 37.5                                                                                |
|            | OO         | 14.1                                                 | 87.9                                                                                      | 12.1 | 0    | 0    | 0                                                                                   |
|            | MM         | 12.0                                                 | 16.9                                                                                      | 79.6 | 0    | 3.5  | 1.0                                                                                 |
|            | HH         | 11.4                                                 | 20.1                                                                                      | 51.4 | 28.5 | 0    | 0                                                                                   |
|            | II         | 9.7                                                  | 38.5                                                                                      | 35.3 | 26.2 | 0    | 50.8                                                                                |
|            | AA         | 8.6                                                  | 0                                                                                         | 92.6 | 2.6  | 4.8  | 26.2                                                                                |
|            | FF         | 7.7                                                  | 0                                                                                         | 100  | 0    | 0    | 55.4                                                                                |
|            | GG         | 5.0                                                  | 25                                                                                        | 33.5 | 35.4 | 6.1  | 6.1                                                                                 |
|            | KK         | 4.6                                                  | 7.4                                                                                       | 92.2 | 0    | 0    | 55.1                                                                                |
|            | LL         | 3.7                                                  | 67.7                                                                                      | 32.3 | 0    | 0    | 10.1                                                                                |
|            | JJ         | 1.1                                                  | 34.6                                                                                      | 0    | 65.4 | 0    | 65.4                                                                                |

Figure 6. Douglas-fir beetle collected per day by collection round at each location and over entire fire area. Numbers are estimated from dry weights. Peak beetle flight occurred early June 2000.



capture overflow and reemergent beetles. Elevation and stand composition appears to have negatively affected trap collections on the highest lines (FF, GG, HH, II, JJ) on Fly Hills.

The 54 WPB traps collected 120,121 beetles throughout the season (Table 2). Douglas-fir beetles were also captured in traps baited for WPB and vice-versa. Attack on fir around WPB trap sites was also found. Commercial baits for WPB and DFB both contain frontalinal, and therefore are cross-attractive to both beetle species.

### MCH

The chemical MCH is an antiaggregation pheromone produced by the DFB and is used to signal incoming beetles that a target tree is reaching maximum beetle capacity. Release devices containing this chemical may prevent mass attack on trees when present in sufficient concentrations (Ross *et al.* 1996) by means of deterrence and flight disruption. The MCH bubblecap product produced by Phero Tech Inc. is not registered in Canada. Therefore, the use of this product requires a Research Permit from the Health Canada Pest Management Regulatory Agency (PMRA) and a Special Use permit from the Pesticide Management Program of B.C. Ministry of Environment Lands and Parks (MOELP). The Environmental

Protection Agency (EPA) in the United States has recently registered this product as a "biochemical pesticide".

The objective of deploying MCH was to protect living trees in combination with the use of attractant tactics. This treatment was used in sensitive, riparian habitats and near private lands in an attempt to prevent the spread of beetles into these susceptible areas. The release devices were placed parallel to the slope break above the gully sidewalls on both sides of two community watersheds (Kernaghan and Wallenstein Creeks) on Fly Hills (Fig. 4). They were also placed along 6.2 km of crown/private property interface on the northeast side of the valley. Bubblecaps were deployed in 3 parallel lines 10 m apart and were spaced 5 to 7 m apart on the lines. They were attached to the north side of any available tree, snag, shrub or piece of debris. Ten thousand bubblecaps were deployed.

The MCH bubblecaps were installed early in April, and in mid-August a walkthrough of the MCH-treated area was performed. A fifty meter wide survey strip (including 10 m on either side of the treated area) was assessed for the presence of newly attacked Douglas-fir trees.

The success of the MCH treatment was difficult to assess. Less than 10 attacked trees were found in 50 m wide survey strip over 6 km of private property bordering the Mt. Ida side, except for a small patch of trees in an area heavily attacked the previous year. Creek protection may have been less successful due to the geography of the areas and to the existing population within the drainages. Still, numbers of attacked trees appeared lower than the previous year.

### Trap Tree Patches

During winter 2000, 16 potential trap tree locations were identified on the east side of the valley: 9 on the north face of Mt. Ida; and 7 in the Wall Creek area. A total of 350 trees were felled by mid-March. An additional 250 trees were added to these patches in early July as overflow attack on trees was detected. Original trap trees were reaching their capacity and reemergence was anticipated. Licencees were responsible for 15 trap tree patches on Fly Hills.

After July, little additional overflow attack was found around trap tree patches. Douglas-fir beetle galleries were observed at all trap tree locations on the Mt. Ida side of the valley. Eleven of 16 patches had moderate to high DFB occupancy (>50% of the infested bark occupied by DFB) (Table 4). DFB presence at three lower elevation patches was very low, as secondary beetles occupied the majority of the infested bark area. All patches had varying incidence of attack by secondary bark beetles and woodborers. Parent adults and galleries of *Pseudobylestinus* sp., *Pityophthorus* sp. and fir engravers (*Scolytus* sp.) were found. Entrance holes and larvae of cerambycid and buprestid woodborers were also observed. Some attack by these beetles was expected due to elevated numbers in fire-scorched or killed trees in the area.

Table 4. Mt. Ida trap tree patch examination, Fall 2000. Typical percent occupancy of the bark by DFB galleries was estimated as low (<50% of bark occupied by DFB galleries), moderate (50-70% DFB galleries) or high (70-100% DFB galleries) for a group of trees (n=10) in each patch. Secondary beetles observed are also indicated.

| Patch | Location   | Total Number of Trees Felled | DFB Occupancy | Secondary beetles observed                                                                   |
|-------|------------|------------------------------|---------------|----------------------------------------------------------------------------------------------|
| 1     | Mt Ida N.  | 20                           | low           | <i>Pseudobylestinus</i> , <i>Pityophthorus</i> , <i>Scolytus</i> , Cerambycidae              |
| 2     | Mt Ida N.  | 57                           | low           | <i>Pseudobylestinus</i> , <i>Pityophthorus</i> , Buprestidae                                 |
| 3     | Mt Ida N.  | 30                           | low           | <i>Pseudobylestinus</i> , <i>Pityophthorus</i> , <i>Scolytus</i> , Cerambycidae              |
| 4     | Mt Ida N.  | 68                           | low           | <i>Pseudobylestinus</i> , Cerambycidae, Buprestidae                                          |
| 5     | Mt Ida N.  | 23                           | high          | <i>Pseudobylestinus</i>                                                                      |
| 6     | Mt Ida N.  | 27                           | mod           | <i>Pseudobylestinus</i> , <i>Pityophthorus</i> , <i>Scolytus</i>                             |
| 8     | Mt Ida N.  | 19                           | mod           | <i>Pseudobylestinus</i> , <i>Pityophthorus</i> , <i>Scolytus</i>                             |
| 9     | Mt Ida N.  | 71                           | high          | <i>Pseudobylestinus</i>                                                                      |
| 10    | Wall Creek | 50                           | mod           | <i>Pseudobylestinus</i> , <i>Scolytus</i> , Cerambycidae                                     |
| 11    | Wall Creek | 35                           | mod           | <i>Pseudobylestinus</i> , <i>Pityophthorus</i> , <i>Scolytus</i> , Cerambycidae, Buprestidae |
| 12    | Wall Creek | 52                           | high          | <i>Pseudobylestinus</i>                                                                      |
| 13    | Wall Creek | 19                           | mod           | <i>Pseudobylestinus</i>                                                                      |
| 14    | Wall Creek | 36                           | mod           | <i>Pseudobylestinus</i>                                                                      |
| 15    | Wall Creek | 48                           | low           | <i>Pseudobylestinus</i> , <i>Pityophthorus</i> , <i>Scolytus</i> , Cerambycidae, Buprestidae |
| 16    | Wall Creek | 28                           | mod           | <i>Pseudobylestinus</i> , Buprestidae                                                        |

## Discussion

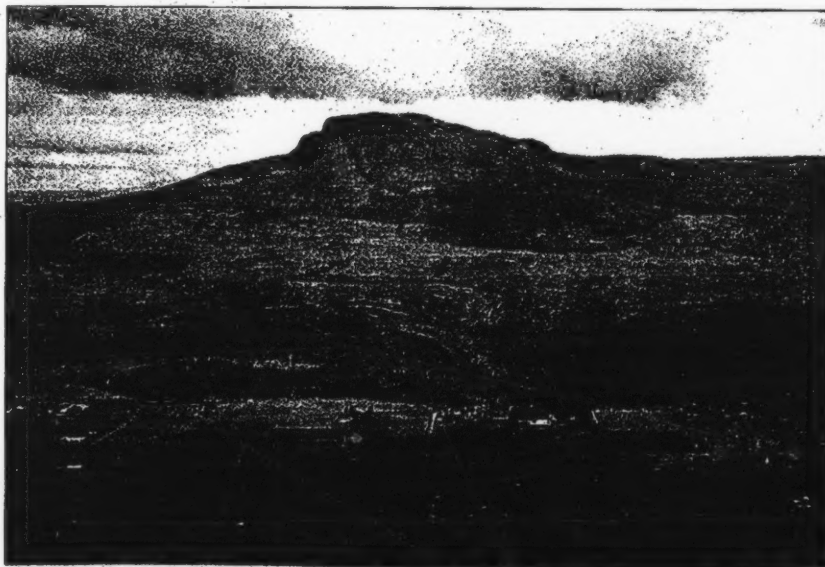
Overall the results are very positive. The major success indicator for this management plan is the low level of new green attack found post-beetle flight 2000. Only 11 hectares of sanitation harvest (including trap tree patches and overflow around trap sites) were scheduled for winter of 2000/2001 on the Mt. Ida side. Another indicator is the apparent lack of a later summer beetle flight (based on very low trap catch numbers after mid-June). This may be explained by the trapping and removal of the majority of the resident beetles during the first flight period, resulting in fewer re-emergent beetles in the later flight period.

Several lessons were learned or reaffirmed regarding implementation of the three management tactics. Overflow attack on susceptible trees should be expected near trap sites and consideration for their removal may be planned in advance. The susceptibility of the adjacent host near trap tree and funnel trap sites should also be considered. For example, the presence of a root disease centre in close proximity to a trap tree patch on Wall Creek may have resulted in a larger than expected amount of overflow attack. It was also learned that caution must be used when mass trapping for both WPB and DFB in an area because of common lure components – in this case frontalinal. Overflow attack by either beetle should be anticipated when deploying these baits in the proximity of either host tree. In the case of this project, DFB overflow was found in proximity to WPB trap sites, as placement of these traps did not take into account their proximity to live fir trees.

The operational suitability and potential for success of mass trapping as compared with conventional tactics (such as trap trees and sanitation harvest) depends on several factors:

- 1) the stand susceptibility and risk coupled with other (potentially conflicting) management objectives;
- 2) the potential for sanitation harvest;
- 3) the availability and accessibility of suitable trap tree sites in proximity to the infestation;
- 4) the quality of infestation data identifying population size and location;
- 5) the budget and resources available (mass trapping requires qualified personnel to set-up, maintain and monitor trap sites over several months with no capital return while conventional tactics require less time commitment and fibre recovery is a return on investment).

The use of MCH appears to show promise, however the operational deployment of the bubblecaps requires further examination. Currently the use of this product is only permitted under an approved Emergency Use or Research Permit. Canadian registration is a prerequisite to this product becoming a part of a manager's available tactics.



*View of the northside  
of Mt. Ida, taken in  
spring 2000.*

## 2001 Management Plans

All sanitation harvesting was completed on Mt. Ida on February of 2001, in cooperation with the local native bands. On Fly Hills, less sanitation harvest was necessary because of the limited host material and mixed timber types. The majority of trees that could not be accessed for harvest will be disposed of by burning the infested portion of the bark.

It is anticipated that a smaller scale trapping program (approximately 40% of 2000) will occur in 2001 to contain remnant populations. Trap site locations will focus on areas in close proximity to the fire edge where susceptible host is present. The few inoperable areas with known 2000 green attack remaining will also be targeted for trapping. On Fly Hills, special attention will be made to the creek drainages, as it is known remnant DFB populations exist in these areas. A summary report for the 2001 year will be available in the new year.

The WBP trapping portion of the program will not be continued, as risk to existing pine is now considered low. The majority of the 2000 WPB attack was removed in conjunction with the DFB sanitation harvest this past winter.

Aerial monitoring of adjacent areas will continue and ground surveys will be initiated if problem areas are found. Continued communication and cooperation with licencees, First Nations and the public is important for the long-term success of beetle management in this area.



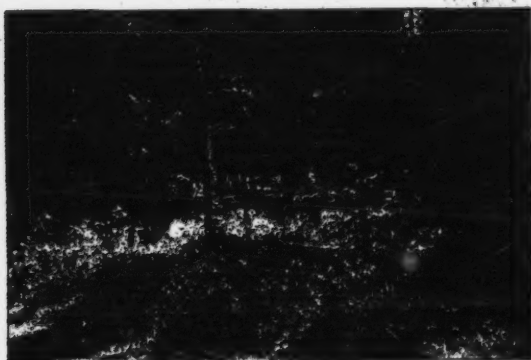
*Aerial view of N. Mt. Ida with Salmon Arm in the distance (top). Nicole Jeans-Williams collecting beetles from a funnel trap on the Fly Hills side (bottom).*



## Acknowledgements

We would like to thank the following for their support and effort in making this project a success:

- Kamloops Region lab crew, Ministry of Forests: Patricia Woods, Phong Phan, Trisha Rimmer and Kelly Hicks
- John Borden, Professor, Simon Fraser University
- Darrell Ross, Assoc. Professor, Oregon State University
- Phero Tech Inc.
- Carol Randall, Entomologist, U.S. Forest Service, Coeur d'Alene, Idaho
- Sandy Kegley, Entomologist, U.S. Forest Service, Coeur d'Alene, Idaho
- Hal Weiser, Professor, University of Calgary
- Silvatech Consulting Ltd.
- Janice Hodge, JCH Forest Pest Management
- Salmon River Watershed Society: Dorothy Argent, Mike Wallis, Margaret Churnka and Field Crew
- Federated Co-operatives Ltd.
- Tolko Industries Ltd., Lavington Div.
- Bell Pole Co. Ltd., Salmon Arm
- Teton Lumber Corporation
- Small Business Forest Enterprise Program, Salmon Arm
- Salmon Arm District Management Team:
  - Ron Racine, District Manager
  - Dave Hails, Operations Manager
  - Paul Knowles, Operations Manager
  - Susan Ladouceur, Corporate Services & Operations Manager
  - The Staff of the Salmon Arm Forest District Office
- This project has received favorable attention through the local newspapers (i.e. Salmon Arm Observer) and television news media (i.e. BCTV and CHBC, Kelowna). The television program "Westland" has filmed a segment on the SRWS and included excerpts of this project. The SRWS also invited the District to present an educational seminar to the local community on this bark beetle management project, January 2001.



*Patch of trap trees located at Wall Creek (top). Smoke and flames of the Silver Creek fire, summer 1998 (bottom).*

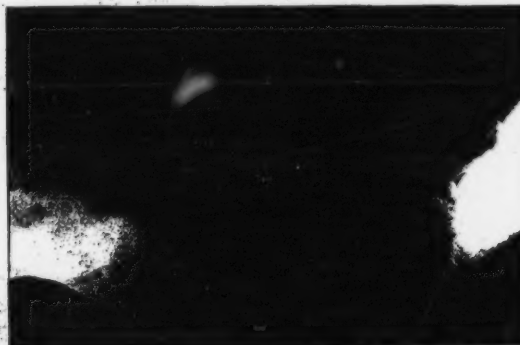


Photo Courtesy Salmon Arm Observer

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MCH bubblecap on tree stump (left), and boles of charred trees in the aftermath of the Silver Creek fire (right).



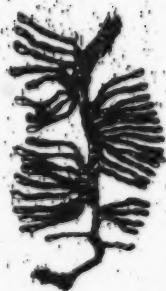
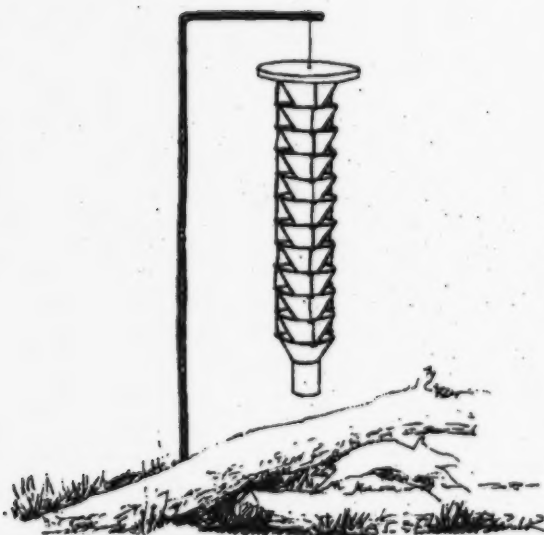


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*Line drawings of (from left to right)  
Lindgren funnel traps used to collect  
beetles, Douglas-fir beetle galleries (note  
central parent gallery with larval  
galleries radiating out from it at right  
angles), and the Douglas-fir beetle.  
*Dendroctonus pseudotsugae*.*

